Science
Office of Science

Overview

Appropriation Summary by Program

(dollars in thousands)

	FY 2005 Current Appropriation	FY 2006 Original Appropriation	FY 2006 Adjustments	FY 2006 Current Appropriation	FY 2007 Request
Science					
Basic Energy Sciences	1,083,616	1,146,017	-11,460[a]	1,134,557	1,420,980
Advanced Scientific Computing Research	226,180	237,055	-2,371[a]	234,684	318,654
Biological and Environmental Research	566,597	585,688	-5,857[a]	579,831	510,263
High Energy Physics	722,906	723,933	-7,239[a]	716,694	775,099
Nuclear Physics	394,549	370,741	-3,707[a]	367,034	454,060
Fusion Energy Sciences	266,947	290,550	-2,906[a]	287,644	318,950
Science Laboratories Infrastructure	37,498	42,105	-421[a]	41,684	50,888
Science Program Direction	154,031	160,725	-1,607[a]	159,118	170,877
Workforce Development for Teachers and Scientists	7,599	7,192	-72[a]	7,120	10,952
Safeguards and Security	72,773	74,317	-687[a]	73,630	76,592
Small Business Innovation Research/ Small Business Technology Transfer	113,621[b]	—	—	—	—
Subtotal, Science	3,646,317	3,638,323	-36,327	3,601,996	4,107,315
Less use of prior year balances	-5,062	—	—	—	—
Less security charge for reimbursable work	-5,605	-5,605	—	-5,605	-5,605
Total, Science	3,635,650	3,632,718	-36,327	3,596,391	4,101,710

Preface

As part of the President's American Competitiveness Initiative, the Office of Science (SC) request for Fiscal Year (FY) 2007 is $4,101,710,000; an increase of $505,319,000, or 14.1%, from the FY 2006 appropriation. The request funds investments in basic research that are critical to both the future economic competitiveness of the United States and to the success of Department of Energy (DOE) missions in national security and energy security; advancement of the frontiers of knowledge in the physical sciences and areas of biological, environmental, and computational sciences; and provision of world-class research facilities for the Nation's science enterprise.

SC provides the basic research that underpins the Department's technically complex missions. Part of this support is in the form of large-scale scientific user facilities that form the backbone of modern research. The suite of forefront facilities includes the world's highest energy proton accelerator—Fermi National Accelerator Laboratory's (Fermilab's) Tevatron—and the soon to be operational Spallation

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[a] Reflects a rescission in accordance with P.L. 109–148, the Emergency Supplemental Appropriations Act to Address Hurricanes in the Gulf of Mexico and Pandemic Influenza, 2006.
[b] Includes $77,842,000 reprogrammed within SC and $35,779,000 transferred from other DOE programs.

Neutron Source (SNS). SC facilities represent a continuum of unique capabilities that meet the needs of a diverse set of nearly 20,000 researchers each year. For example, the National Synchrotron Light Source (NSLS) began ultraviolet operations in 1982 and, initially, primarily enabled physical science research. However, through the 1990's the numbers of researchers from the life sciences rapidly grew as the characteristics of this facility better suited the needs of researchers who study protein structure. Today, the NSLS is playing a major role in the Protein Structure Initiative, a national effort to find the three-dimensional shapes of a wide range of proteins, while also providing a suite of beamlines to the soon to be available Center for Functional Nanomaterials and a host of other research efforts.

Within the Science appropriation, SC has 10 programs: Basic Energy Sciences (BES), Advanced Scientific Computing Research (ASCR), Biological and Environmental Research (BER), High Energy Physics (HEP), Nuclear Physics (NP), Fusion Energy Sciences (FES), Science Laboratories Infrastructure (SLI), Science Program Direction (SCPD), Workforce Development for Teachers and Scientists (WDTS), and Safeguards and Security (S&S).

This Overview will describe Strategic Context, Mission, Benefits, Strategic Goals, and Funding by General Goal. These items together put the appropriation request in perspective. The Annual Performance Results and Targets, Means and Strategies, and Validation and Verification sections address how the goals will be achieved and how performance will be measured. Finally, this Overview will address the Research and Development (R&D) Investment Criteria, Program Assessment Rating Tool (PART), and Significant Program Shifts.

Strategic Context

Following publication of the Administration's National Energy Policy, the Department developed a Strategic Plan that defines its mission, four strategic goals for accomplishing that mission, and seven general goals to support the strategic goals. Each appropriation has developed quantifiable goals to support the general goals. Thus, the "goal cascade" is the following:

Department Mission ➨ Strategic Goal (25 yrs) ➨ General Goal (10–15 yrs) ➨ Program Goal (Government Performance and Results Act [GPRA] Unit) (10–15 yrs).

To provide a concrete link between budget, performance, and reporting, the Department developed a "GPRA Unit" concept. Within DOE, a GPRA Unit defines a major activity or group of activities that support the core mission and aligns resources with specific goals. Each GPRA Unit has completed or will complete a PART. A unique program goal was developed for each GPRA unit. A numbering scheme has been established for tracking performance and reporting.

The goal cascade accomplishes two things. First, it ties major activities for each program to successive goals and, ultimately, to DOE's mission. This helps ensure the Department focuses its resources on fulfilling its mission. Second, the cascade allows DOE to track progress against quantifiable goals and to tie resources to each goal at any level in the cascade. Thus, the cascade facilitates the integration of budget and performance information in support of the GPRA and the President's Management Agenda (PMA).

Another important component of our strategic planning—and the PMA—is use of the Administration's R&D investment criteria to plan and assess programs and projects. The criteria were developed in 2001 and further refined with input from agencies, Congressional staff, the National Academy of Sciences, and numerous private sector and nonprofit stakeholders.

The chief elements of the R&D investment criteria are quality, relevance, and performance. Programs must demonstrate fulfillment of these elements. For example, to demonstrate relevance, programs are expected to have complete plans with clear goals and priorities. To demonstrate quality, programs are expected to commission periodic independent expert reviews. There are several other requirements, many of which R&D programs have and continue to undertake.

An additional set of criteria were established for R&D programs developing technologies that address industry issues. Some key elements of the criteria include: the ability of the programs to articulate the appropriateness and need for Federal assistance; relevance to the industry and the marketplace; identification of a transition point to industry commercialization (or of an off-ramp if progress does not meet expectations); and the potential public benefits, compared to alternative investments, that may accrue if the technology is successfully deployed.

The Office of Management and Budget (OMB)-Office of Science and Technology Policy (OSTP) guidance memorandum to agencies (http://www.ostp.gov/html/budget/2007/ostp_omb_guidancememo_FY07.pdf) describes the R&D investment criteria and identifies steps agencies should take to fulfill them. Where appropriate, throughout these justification materials, specific R&D investment criteria and requirements are cited to explain the Department's allocation of resources.

Mission

SC's mission is to deliver the discoveries and scientific tools that transform our understanding of energy and matter and advance the national, economic, and energy security of the United States.

Benefits

Developments at the nanoscale are expected to make major contributions to meeting DOE's applied mission needs such as strong, tough, ductile, lightweight materials with low failure rates that will improve the fuel efficiency and safety of ground and air transportation; smart materials that will range from paints that change color with temperature to windows that respond to thermal inputs and improve energy efficiency; nanostructured catalysts that will lead to cleaner, less expensive, more environmentally friendly petroleum refining; better batteries and fuel cells; improved chemical and product manufacturing; and innovative systems for harvesting light and storing energy that will dramatically improve solar energy conversion.

The knowledge developed from the Genomics: GTL program on understanding microbial genes and protein complexes, their regulation, and their functional roles in an ecosystem can lead both to greater energy security and a stabilization of net atmospheric CO_2 emissions. Currently, petroleum refineries "crack" raw oil through heat and catalysis to create gasoline and other petroleum products. In the future, we envision biorefineries that, in a one-step process, use microbial cellulase enzymes to crack the complex cellulose and hemicellulose in plant walls into simple sugars and microbially ferment those sugars into ethanol and other biobased products. Genomics: GTL research findings can accelerate this vision by improving the understanding of both plant cell-wall construction and the microbial enzymes necessary to deconstruct those walls. Microbes could also enable the inexpensive production of hydrogen by consuming a hydrogenated feedstock and releasing hydrogen. In addition, plants use the sun's energy to convert atmospheric carbon dioxide to biomass (e.g., leaves, roots, stems, and seeds) composed mainly of cellulose and lignin. Some biomass ultimately becomes incorporated into the soil where its carbon may be sequestered for hundreds of years. Understanding plant genes, their regulation and the role of microbes in the plant's root zone ultimately will enable manipulation of their carbon storage processes. Specialized, large-scale user facilities are needed to achieve the necessary economies of scale and output of molecular data associated with the Genomes: GTL effort.

Through investments in HEP and NP, SC has historically provided the Nation with fundamental knowledge about the laws of nature as they apply to the basic constituents of matter, and the forces between them. This knowledge rapidly travels from scientific journals to textbooks where it informs the creative vision of scientists, engineers, and entrepreneurs. This final path is neither linear nor overt, but we know that understanding the laws of nature is the key to technological progress. With this request, SC will focus efforts in these areas to places of world leadership and experiments with the greatest potential for radical discovery. The Relativistic Heavy Ion Collider (RHIC) will continue to explore new states of matter recently discovered there, providing a direct probe of the conditions found in exotic locations of the universe and at the first moments of the birth of the universe. Significant advances will be made in nuclear structure and nuclear astrophysics with the study of energy production in stars, the formation of heavy elements, and explosive stellar events. The Continuous Electron Beam Accelerator Facility (CEBAF) at the Thomas Jefferson National Accelerator Facility (TJNAF) provides unique world-wide capabilities in polarized electron beam studies of the quark structure of the nucleon—it is the world's most powerful electron "microscope" for studying the nucleus with unprecedented resolving power. The Fermilab Tevatron, the world's highest energy accelerator, is turning its powerful beams to solve the mystery of the existence of mass, to find the first evidence of a supersymmetric universe, and to explore the distinct possibility of finding extra dimensions of space and time in which we live. The B-factory at the Stanford Linear Accelerator Center (SLAC) is providing precision measurements of how matter and antimatter behave differently in the decays of short-lived exotic particles known as B-mesons, considered by physicists to be vital to understanding why the whole universe appears to be predominantly matter, rather than an equal quantity of matter and antimatter. There is also a broad program of experiments that studies those aspects of the fundamental nature of particles, forces, and the universe that cannot be determined solely through the use of accelerators, including the search for or measurement of dark matter and dark energy. A recent example is the unexpected and significant finding that neutrinos have mass, discovered by studying solar and cosmic ray neutrinos.

Strategic, General, and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The Science appropriation supports the following goal:

Science Strategic Goal: To protect our national and economic security by providing world-class scientific research capacity and advancing scientific knowledge.

General Goal 5, World-Class Scientific Research Capacity: Provide world-class scientific research capacity needed to: ensure the success of Department missions in national and energy security; advance the frontiers of knowledge in physical sciences and areas of biological, medical, environmental, and computational sciences; or provide world-class research facilities for the Nation's science enterprise.

The programs funded by the Science appropriation have the following six Program Goals which contribute to General Goal 5 in the "goal cascade":

Program Goal 05.22.00.00: Advance the Basic Science for Energy Independence—Provide the scientific knowledge and tools to achieve energy independence, securing U.S. leadership and essential breakthroughs in basic energy sciences.

Program Goal 05.23.00.00: Deliver Computing for Accelerated Progress in Science—Deliver forefront computational and networking capabilities to scientists nationwide that enable them to extend the frontiers of science, answering critical questions that range from the function of living cells to the power of fusion energy.

Program Goal 05.21.00.00: Harness the Power of Our Living World—Provide the biological and environmental discoveries necessary to clean and protect our environment, offer new energy alternatives, and fundamentally change the nature of medical care to improve human health.

Program Goal 05.19.00.00: Explore the Fundamental Interactions of Energy, Matter, Time, and Space—Understand the unification of fundamental particles and forces and the mysterious forms of unseen energy and matter that dominate the universe, search for possible new dimensions of space, and investigate the nature of time itself.

Program Goal 05.20.00.00: Explore Nuclear Matter, from Quarks to Stars—Understand the evolution and structure of nuclear matter, from the smallest building blocks, quarks, and gluons; to the stable elements in the Universe created by stars; to unique isotopes created in the laboratory that exist at the limits of stability and possess radically different properties from known matter.

Program Goal 05.24.00.00: Bring the Power of the Stars to Earth—Answer the key scientific questions and overcome enormous technical challenges to harness the power that fuels our sun.

Contribution to General Goals

Six of the programs within the Science appropriation directly contribute to General Goal 5 as follows:

BES contributes to General Goal 5 by advancing science through atomic- and molecular-level studies in materials sciences and engineering, chemistry, geosciences, and energy biosciences. BES also provides the Nation's researchers with world-class research facilities, including reactor and accelerator-based neutron sources, light sources including the X-ray free electron laser currently under construction, and micro-characterization centers. These facilities provide outstanding capabilities for imaging and characterizing materials of all kinds from metals, alloys, and ceramics to fragile biological samples. Construction of the Spallation Neutron Source will be completed during the 3rd quarter of FY 2006 and will join the suite of BES scientific user facilities. Four Nanoscale Science Research Centers will begin their first full year of operation in FY 2007—the Center for Nanophase Materials Sciences at Oak Ridge National Laboratory, the Molecular Foundry at Lawrence Berkeley National Laboratory, the Center for Nanoscale Materials at Argonne National Laboratory, and the Center for Integrated Nanotechnologies at Sandia National Laboratories and Los Alamos National Laboratory. A fifth Center, the Center for Functional Nanomaterials at Brookhaven National Laboratory, will be in its final year of construction. The Linac Coherent Light Source (LCLS) at Stanford Linear Accelerator Center is fully funded in FY 2007, including partial support for the SLAC linac. The Transmission Electron Aberration Corrected Microscope project continues as a Major Item of Equipment (MIE). Support is provided for R&D and project engineering and design (PED) activities for the National Synchrotron Light Source–II (NSLS–II) to enable the study of material properties and functions, particularly materials at the nanoscale, at a level of detail and precision never before possible. BES will increase support for basic research for the President's Hydrogen Fuel Initiative and will continue ongoing Scientific Discovery through Advanced Computing (SciDAC) efforts.

The ASCR program contributes to General Goal 5 by advancing mathematics and computer science, and developing the specialized algorithms, the scientific software tools, and the software libraries needed by DOE researchers to effectively use high-performance computing and networking hardware for scientific discovery. The ASCR program has been a leader in the computational sciences for several decades and has been acknowledged for pioneering accomplishments. The Leadership Computing activity will be expanded to Argonne National Laboratory to provide up to 100 teraflops of high performance computing capability with low electrical power needs to advance scientific understanding in areas that include materials science, biology, and advanced designs of nuclear reactors. The Leadership Computing

Facility at Oak Ridge National Laboratory will be upgraded to deliver 250 teraflops of peak capability in FY 2007. In FY 2007, the Energy Science Network (ESnet) will deliver a backbone network with two to four times the capability of today's network, to support the science mission of the Department. A procurement is planned in FY 2006 for the next generation of high performance resources at the National Energy Research Scientific Computing Center (NERSC) to be delivered in early FY 2007. This NERSC-5 system is expected to provide 100–150 teraflops of peak computing capacity. Corresponding investments in research and evaluation prototypes will help prepare scientists for petascale computing. ASCR will also continue core research efforts in applied mathematics and computer science and expand efforts in the SciDAC program and institutes.

BER contributes to General Goal 5 by advancing energy-related biological and environmental research in genomics and our understanding of complete biological systems, such as microbes that produce ethanol from cellulose or make hydrogen; by developing models to predict climate over decades to centuries; by developing science-based methods for cleaning up environmental contaminants; by providing regulators with a stronger scientific basis for developing future radiation protection standards; and by conducting limited research in medical imaging, radiopharmaceuticals, and development of an artificial retina. In FY 2007, BER will continue the Genomics: GTL program as a top priority, employing a systems approach to biology at the interface of the biological, physical, and computational sciences for DOE's energy security and environmental mission needs. Structural Biology infrastructure and innovative research on the biological effects of low dose radiation needed for future radiation protection standards will be sustained. BER continues as a pivotal partner in the interagency Climate Change Science Program focusing on the principal uncertainties of the causes and effects of climate change, the global carbon cycle, developing of predictive models for climate change over decades to centuries, and basic research for biological sequestration of carbon. Basic research in Environmental Remediation continues, at a reduced level, supporting fundamental research at the interfaces of biology, chemistry, geology, hydrology, and physics for solutions to environmental contamination challenges and terminating high level waste research. The Medical Sciences research program continues its principal focus on the artificial retina and medical imaging, including radiopharmaceuticals for imaging, at FY 2006 levels. Support for user facilities increases to meet growing scientific and technical demands for users of the Environmental Molecular Sciences Laboratory (EMSL), Production Genomics Facility (PGF), Atmospheric Radiation Measurement (ARM) sites, and Free Air Carbon Dioxide Enrichment (FACE) sites.

HEP contributes to General Goal 5 by advancing understanding of the basic constituents of matter, dark energy and dark matter, the lack of symmetry between matter and antimatter in the current universe, and the possible existence of other dimensions, collectively revealing key secrets of the universe. The FY 2007 budget request also contributes to this program goal by placing high priority on operations, upgrades, and infrastructure for the three major HEP user facilities (the Tevatron Collider and Neutrinos at the Main Injector [NuMI] at Fermilab and the B-factory at SLAC), to produce maximum scientific data. HEP and BES will jointly support accelerator operations at SLAC through the construction of the LCLS. The U.S. HEP program in FY 2007 will continue to lead the world with these forefront user facilities at Fermilab and SLAC, but these facilities will complete their scientific missions by the end of the decade. Thus the longer-term HEP program supported by this request begins to develop new cutting-edge facilities in targeted areas (for example, neutrino physics) that will establish U.S. leadership in these areas (see Significant Shifts) in the next decade, when the centerpiece of the world HEP program will reside at CERN. The FY 2007 budget also provides support for final installation, commissioning, and initial operations of the U.S.-supplied components of the Large Hadron Collider (LHC) at the European Organization for Nuclear Research (CERN) Laboratory.

NP contributes to General Goal 5 by supporting innovative, peer-reviewed scientific research to advance knowledge and provide insights into the nature of energy and matter, and, in particular, to investigate the fundamental forces which hold the nucleus together and determine the detailed structure and behavior of the atomic nuclei. The program builds and supports world-leading scientific facilities and state-of-the-art instruments necessary to carry out its basic research agenda. NP also supports an effort in nuclear data that collects, evaluates, and disseminates nuclear physics data for basic nuclear research and for applied nuclear technologies, such as the design of reactors and national and homeland security. World-leading efforts on studies of hot dense nuclear matter and the origin of the proton spin with beams at the Relativistic Heavy Ion Collider (RHIC) will continue, including implementation of required instrumentation to realize scientific goals. A new Electron Beam Ion Source (EBIS) begins construction together with the National Aeronautics and Space Administration (NASA) to provide RHIC with more cost-effective, reliable operations. In addition to RHIC efforts, the High Energy Density Physics activities include NP contributions to enhance heavy ion capabilities of existing LHC experiments and the accompanying research program at universities and laboratories. Operations of the Continuous Electron Beam Accelerator Facility (CEBAF) are supported to provide high-energy electron beams to investigate a unique property called “confinement” that binds together the fundamental constituents of protons and neutrons, particles called quarks and gluons. At the FY 2007 level of funding, the accelerator provides beams simultaneously to all three experimental halls to better understand the structure of the nucleon. PED begins on a significant upgrade of the facility, the 12 GeV CEBAF Upgrade project. NP also continues efforts in nuclear structure/astrophysics, fundamental interactions, and neutrinos. Efforts at the Argonne Tandem Linear Accelerator System (ATLAS) and the Holifield Radioactive Ion Beam Facility (HRIBF) will be supported to focus on investigating new regions of nuclear structure, studying interactions in nuclear matter like those occurring in neutron stars, and determining the reactions that created the nuclei of the chemical elements inside stars and supernovae. Generic R&D in radioactive ion beam development, relevant for next-generation facilities in nuclear structure and astrophysics, is supported in FY 2007. The GRETINA gamma-ray tracking array, currently under fabrication, revolutionizes gamma ray detection technology and offers dramatically improved capabilities to study the structure of nuclei at ATLAS and HRIBF. The Fundamental Neutron Physics Beamline (FNPB) under fabrication at SNS will provide a world-class capability to study the neutron decay properties, leading to a refined characterization of the weak force. Investments are made to initiate the fabrication of a neutron Electric Dipole Moment experiment in the search for new physics beyond the Standard Model, for fabrication of instrumentation that will provide opportunities for U.S. involvement in the heavy-ion program at the CERN Large Hadron Collider, and for design and R&D associated with a Double Beta Decay experiment that will measure the absolute mass of the neutrino.

FES contributes to General Goal 5 by advancing the theoretical and experimental understanding of plasma and fusion science through our domestic activities and a close collaboration with international partners on specialized facilities abroad. FES also contributes to General Goal 5 through participation in ITER, an experiment to study and demonstrate the scientific and technical feasibility of fusion power. ITER is a multi-billion dollar international research project that will, if successful, advance progress towards developing fusion’s potential as a commercially viable and clean source of energy near the middle of the century. The FY 2006 Appropriation provided for a slower start for the U.S. Contributions to the ITER project. The FY 2007 request provides for the continuation of the U.S. Contributions to the ITER MIE project. In FY 2007, the overall Total Project Cost remains unchanged from FY 2006, but the funding requested in FY 2007 is lower than shown in the profile in the FY 2006 budget, and slightly adjusted between the Total Estimated Cost (TEC) and Other Project Cost (OPC) categories to address domestic and international project priorities. The U.S. contributions to the ITER project provides for the

U.S. "in-kind" equipment contributions, U.S. personnel to work at the ITER site, and cash for the U.S. share of common expenses such as infrastructure, hardware assembly, and installation.

Experimental research on tokamaks is continued in FY 2007, with increasing emphasis on physics issues of interest to the ITER project. Operations at the largest facility, the DIII-D tokamak at General Atomics (a private company), will increase from 7 weeks in FY 2006 to 12 weeks in FY 2007, while operations at C-Mod at MIT will increase from 14 to 15 weeks, and operations at the National Spherical Torus Experiment (NSTX) at PPPL will increase from 11 to 12 weeks. Fabrication of the National Compact Stellarator Experiment (NCSX) will continue along the new baseline established in July 2005 with completion expected in July 2009. The General Plasma Science program continues at approximately FY 2006 levels.

Funding by General and Program Goal

(dollars in thousands)

	FY 2005	FY 2006	FY 2007
General Goal 5, World-Class Scientific Research Capacity			
Program Goal 05.22.00.00, Basic Energy Sciences	1,083,616	1,134,557	1,420,980
Program Goal 05.23.00.00, Advanced Scientific Computing Research	226,180	234,684	318,654
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Program Goal 05.19.00.00, High Energy Physics	722,906	716,694	775,099
Program Goal 05.20.00.00, Nuclear Physics	394,549	367,034	454,060
Program Goal 05.24.00.00, Fusion Energy Sciences	266,947	287,644	318,950
Subtotal, General Goal 5, World-Class Scientific Research Capacity	3,260,795	3,320,444	3,798,006
All Other			
Science Laboratories Infrastructure	37,498	41,684	50,888
Program Direction	154,031	159,118	170,877
Workforce Development for Teachers and Scientists	7,599	7,120	10,952
Safeguards and Security	72,773	73,630	76,592
Small Business Innovation Research/Small Business Technology Transfer	113,621	——	——
Total, All Other	385,622	281,552	309,309
Total, General Goal 5 (Science)	3,646,317	3,601,996	4,107,315

Major FY 2005 Accomplishments

An incident solar photon striking a semiconductor solar cell normally produces a single electron-hole pair (exciton) and some excess heat. Experimentalists have recently demonstrated that two or more excitons can be created by absorption of a single photon in an array of lead-selenide nanocrystals. This process is called "impact ionization" and is observed when the photon energy is greater than three times the band gap of the nanocrystal. Multiple excitons from a single photon are formed on the picosecond time scale, and the process occurs with up to 100% efficiency depending on the excess energy of the absorbed photon. If this process could be translated into an operational solar cell, the gain in efficiency for converting light to electrical current would be greater than 35%.

Diatoms are simple single-celled algae, covered with elegant and often very beautiful casings sculpted from silica. They share biochemical features of both plants and animals and are related to the organisms that make up the well known White Cliffs of Dover in England. Scientists have taken a big step toward resolving the paradoxical nature of these odd microbes by sequencing the genome of the marine diatom *Thalassiosira pseudonana*. Analyses of these genes and the proteins they encode confirm that diatoms, in their evolutionary history, apparently acquired new genes by engulfing microbial neighbors including, possibly, genes that provided the diatom with all the machinery necessary for photosynthesis. Diatoms occupy vast swaths of ocean and fresh water, where they play a key role in the global carbon cycle. Diatom photosynthesis yields 19 billion tons of organic carbon—about 40% of the marine carbon produced each year—and thus represent one of nature's key defenses against global warming. Progress in analyzing the diatom genome is also shedding light on how a diatom constructs its intricately patterned glass shell, progress that could benefit both materials and climate change scientists.

The universe may have begun as a "perfect" liquid, not a gas. In April 2005, nuclear physicists working on the four experiments at RHIC presented "White Papers" documenting details and summarizing the evidence for an extraordinary new state of matter obtained from the first three years of RHIC operations. These latest results show that a new state of hot, dense matter was created out of quarks and gluons, but quite different and even more remarkable than had been previously predicted. The matter created in heavy-ion collisions appears to behave like a near "perfect" liquid rather than a fiery gas of free quarks and gluons. The word "perfect" refers to the liquid's viscosity—a friction like property that impedes a fluid's ability to flow. A perfect liquid has no viscosity. The RHIC results are consistent with "ideal" hydrodynamic calculations suggesting that the lowest viscosity possible in a "Quark-Gluon Plasma (QGP) fluid" may be achieved— a stunning discovery that could revise physicists' conception of the earliest moments of the universe.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by the Office of Management and Budget (OMB) to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews.

The current focus is to establish outcome- and output-oriented goals, the successful completion of which will lead to benefits to the public, such as increased national security and energy security, and improved environmental conditions. DOE has incorporated feedback from OMB into the FY 2006 Budget Request, and the Department will take the necessary steps to continue to improve performance.

SC did not complete PARTs for the FY 2007 Budget. In the FY 2005 PART review, OMB assessed six SC programs: ASCR, BES, BER, FES, HEP, and NP. Program scores ranged from 82-93%. Three programs—BES, BER, and NP—were assessed "Effective." Three programs—ASCR, FES, and HEP—were assessed "Moderately Effective." The full PARTs are available on the OMB website at http://www.whitehouse.gov/omb/budget/fy2005/part.html. SC expects to stagger updated PART reviews in the future.

SC has taken steps to enhance public understanding of our revised performance measures. The PART website (http://www.science.doe.gov/measures/) has been improved to better explain what each scientific measure means, why it is important to the Department and/or the research community, and how progress will be measured. Roadmaps with more detailed information on tracking progress toward the long-term measures have been developed with the Scientific Advisory Committees and are posted to this PART website. The Advisory Committees will review progress toward those measures vis-à-vis the roadmaps every three to five years. The first reviews will be conducted in FY 2006. The results of these reviews will be published on the PART website as they become available.

For the FY 2007 budget, OMB has developed PARTWeb—a new interface for PART that facilitates collaboration between agencies and OMB. PARTWeb will link to the new http://ExpectMore.gov website and will improve public access to PART assessments and follow up actions. New actions for Science in 2006 include:

- Implementing the recommendations of past and new external assessment panels, as appropriate;
- Engaging the Advanced Scientific Computing Advisory Committee and other outside groups in regular, thorough scientific assessments of the quality, relevance, and performance of its research portfolio and computing/network facilities;
- A detailed corporate solution for managing and operating the High Flux Isotope Reactor;
- Engaging the National Academies in an independent assessment of the scientific basis and business case for microbial genomics research efforts;
- Developing strategic and implementation plans in response to multiple Congressional requirements for ITER and Fusion Energy Sciences;
- Re-engaging the Fusion Energy Sciences Advisory Committee in a study of the how the program could best evolve over the coming decade to take into account new and upgraded international facilities;
- Developing a strategy and implementation plan for particle accelerator research and development, including a potential international linear collider;
- Engaging the National Academies to help develop a realistic long term plan for High Energy Physics that is based on prioritized scientific opportunities and input from across the scientific community;
- Engaging the National Academies, including experts outside of nuclear physics, to study the scientific capabilities of a proposed rare isotope accelerator in an international context; and
- Maximizing operational efficiency of major Nuclear Physics experimental facilities in response to increasing power costs.

Significant Policy or Program Shifts

Basic Energy Sciences—Over the next two to three years, the Spallation Neutron Source (SNS) will fabricate and commission instruments and increase power to full levels. A new major item of equipment is funded that will allow the fabrication of four to five additional instruments for the SNS, thus nearly completing the initial suite of twenty four instruments that can be accommodated in the high-power target station. BES also supports energy security through basic research for effective solar energy utilization, basic research for the hydrogen economy, and basic research underpinning advanced nuclear energy power.

Advanced Scientific Computing Research— In FY 2007, ASCR supports increases in SciDAC activities, the initiation of new university based competition for SciDAC Institutes, and enhancements to SciDAC that develop leadership class computing simulations for petaflop-scale computers. Increases in funding for both production and leadership computing facilities will enable continued scientific leadership through high performance computing. The success of this effort is built on the enhancements to the research and evaluation prototype and computer science research activities. The Research and Evaluation Prototypes activity will prepare users for the next generations of scientific computers and reduce the risk of major procurements. Increases in funding would also enable ESnet to evolve to manage the increased data flows from petascale computers and the experimental facilities that are critical to the Nation's future.

Biological and Environmental Research—Development of a global biotechnology-based energy infrastructure requires a science base that enables scientists to redesign specific proteins, biochemical pathways, and even entire plants or microbes. Studies have suggested that, by 2100, biotechnology-based energy use could equal all global fossil energy use today. Two examples of biofuels are ethanol derived from the cellulose in plant cell walls (cellulosic ethanol) and hydrogen produced from water using energy from the sun (biophotolytic hydrogen). Within the Genomics: GTL program, BER will develop the understanding needed to advance biotechnology-based strategies for biofuel production. In addition, the FY 2007 budget includes funds for the continued expansion of the Genomics: GTL program—a program at the forefront of the biological revolution. Funding reductions are initiated in the Environmental Remediation Research and in the Climate Change Research Subprograms. High level waste, ocean sciences, and ocean carbon sequestration research are terminated within these two subprograms.

High Energy Physics—Our highest priority HEP R&D effort is the development of an International Linear Collider (ILC), and this request significantly advances the ILC R&D program. Pre-conceptual R&D for the ILC is doubled to enable a strong U.S. leadership role as a part of a comprehensive, coordinated international R&D program. In addition, R&D for other accelerator and detector technologies will continue at an increased level relative to FY 2006. Project engineering and design (PED) will begin on a new detector optimized to detect electron neutrinos, the Electron Neutrino Appearance (EνA) Detector, which will utilize the existing NuMI beam. Participation will begin in a reactor-based neutrino experiment, and R&D for a high-intensity neutrino super beam facility and a double beta decay experiment will continue. These efforts are part of a coordinated neutrino program developed from an American Physical Society study and a joint High Energy Physics Advisory Panel/Nuclear Science Advisory Committee review. In order to explore the nature of dark energy, conceptual R&D for the Super Nova/Acceleration Probe (SNAP) mission concept will continue in FY 2007. SNAP is expected to be a mission concept proposed for a potential interagency-sponsored experiment with NASA, the Joint Dark Energy Mission (JDEM). In addition, to fully determine the nature of dark energy, independent and complementary measurements are scientifically advisable. In FY 2007, additional R&D will be done for ground facilities and/or space-based facilities which could provide these measurements.

Nuclear Physics—The FY 2007 budget request increases support for operations and research by approximately 21% compared to FY 2006. At this level, operations of the four NP National User Facilities allow researchers to make effective progress towards the program's scientific goals and milestones. This budget request supports initiation of research efforts in the CERN LHC heavy ion program and starts PED activities for the 12 GeV CEBAF Upgrade project. NP also supports increases for research relevant to advanced nuclear fuel cycles. While we have a relatively good understanding of the origin of the chemical elements in the cosmos lighter than iron, the production of the elements from iron to uranium remains a puzzle. A next-generation exotic beam facility would allow the U.S. to play a leading role in nuclear structure and astrophysics studies in the next decade. Modest funding for generic R&D in exotic beam development is supported in FY 2007.

Fusion Energy Sciences—The FY 2007 budget continues the redirection of the fusion program to prepare for and participate in the international ITER project. The redirection will require modest reductions in several program elements not directly related to ITER. The FY 2007 request for the U.S. Contributions to ITER MIE project reflects a more modest first two years than was contained in the FY 2006 President's Budget, but maintains the overall Total Project Cost funding cap of $1,122,000,000. The reductions allow for the U.S. to be more consistent with the other ITER parties in the pace of starting the long lead procurements, in providing increased numbers of personnel to the ITER Organization, and in providing cash for common expenses. The profile is preliminary until the baseline scope, cost, and schedule for the MIE project are established, and the Director General Nominee and ITER Organization have achieved a standard mode of operation. SciDAC efforts will increase and will continue development of collaboratory tools to facilitate international fusion collaborations and initiate development of an integrated software environment that can accommodate the wide range of space and time scales and the multiple physical phenomena that are encountered in simulations of fusion systems. The Fusion Simulation Project is a major initiative involving plasma physicists, applied mathematicians, and computer scientists to create a comprehensive set of models of fusion systems, combined with the algorithms required to implement the models and the computational infrastructure to enable them to work together. High Energy Density Physics, Plasma Technology and Materials Research, Experimental Plasma Research, and Fusion Theory will be reduced.

Scientific Laboratory Infrastructure—In FY 2007, SLI will initiate funding for four construction projects: the Seismic Safety Upgrade of Buildings, Phase I, at the Lawrence Berkeley National Laboratory; the Modernization of Building 4500N, Wing 4, Phase I, at the Oak Ridge National Laboratory; the Building Electrical Services Upgrade, Phase II, at the Argonne National Laboratory; and Renovate Science Lab, Phase I, at the Brookhaven National Laboratory. Funding for the Pacific Northwest National Laboratory Physical Sciences Facility is requested in the National Nuclear Security Administration's (NNSA's) Nuclear Non-Proliferation R&D program for FY 2007. This project is co-funded by SC, NNSA, and the Department of Homeland Security. The SLI program will continue full funding for demolition of the Bevatron at Lawrence Berkeley National Laboratory. General plant project (GPP) funding is terminated in FY 2007 because it is supported in other SC programs' budgets in FY 2007.

Science Program Direction—Program direction funding increases by 7.4%, with most of the increase to support an additional 25 FTEs planned to be hired in support of the overall Science program, which is increased by 14.1% in the FY 2007 request. The increase also supports a 2.2% pay raise; an increased cap for SES basic pay; other pay related costs such as the government's contributions for employee health insurance and Federal Employees' Retirement System (FERS); escalation of non-pay categories, such as travel, training, and contracts; and increased e-Gov assessments and other fixed operating requirements across the SC complex. Finally, the increase will cover requirements not requested in previous SCPD budget requests, including travel expenses of SC Advisory Committee members and requirements related to Appendix A of OMB Circular A-123, Management's Responsibility for Internal Control.

Workforce Development for Teachers and Scientists—The Laboratory Science Teacher Professional Development (LSTPD) program increases to expand participation from 108 teachers in FY 2006 to 300 in FY 2007. The Faculty Sabbatical activity was initiated in FY 2005 for faculty from Minority Serving Institutions (MSI) and reduced in FY 2006 due to feedback from MSI faculty who expressed their inability to participate in sabbatical programs and a preference for shorter fellowship-type opportunities. FY 2007 participation will be reduced to two faculty members. The Science Undergraduate Laboratory Internship (SULI) programs will be increased to add approximately 55 students. The Albert Einstein Distinguished Educator Fellowship and the National and Middle School Science Bowls will all continue.

Safeguards and Security—The FY 2007 budget will ensure adequate security posture for SC facilities by protecting fundamental science, national security, and the health and safety of DOE and contractor employees, the public and the environment. FY 2007 funding will cover the implementation of the 2003 Design Basis Threat (DBT). In FY 2007, an increase in funding for the Cyber Security program element is being requested to begin to address the promulgation of new National Institute of Standards and Technology (NIST) requirements which are statutorily required by the Federal Information Security Management Act (FISMA) to improve the Federal and SC laboratory cyber security posture.

Indirect Costs and Other Items of Interest

Institutional General Plant Projects

Institutional General Plant Projects (IGPPs) are miscellaneous construction projects that are each less than $5,000,000 in TEC and are of a general nature (cannot be allocated to a specific program). IGPPs support multi-programmatic and/or inter-disciplinary programs and are funded through site overhead. Examples of acceptable IGPPs include site-wide maintenance facilities and utilities, such as roads and grounds outside the plant fences or a telephone switch that serves the entire facility.

Examples of current year projects are:

- Quadrangle Common Area design and construction at Oak Ridge National Laboratory. This FY 2004 and FY 2005 effort includes lawn, landscaping, sidewalks, lighting, and street improvements to an area of approximately 71,000 square feet. TEC: $2,697,000.
- East Campus Storm Water Upgrades at Oak Ridge National Laboratory. This FY 2005 project will upgrade the East Campus storm water drainage system to prevent flooding of new East Campus facilities. Recent storm modeling of the East Campus watershed has determined that a 500-year storm could produce substantial flooding in the Oak Ridge East Campus. TEC: $750,000
- East Campus Parking Expansion design and construction at Oak Ridge National Laboratory. This project, scheduled for completion in FY 2006, will provide expanded parking capacity for the recently completed Third Party Buildings, Joint Institute for Computational Science/Oak Ridge Center for Advanced Studies, and Research Support Center, as well as the Multiprogram Research Facility. TEC: $3,500,000.

The following displays IGPP funding by site:

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Oak Ridge National Laboratory	9,000	10,000	8,000
Pacific Northwest National Laboratory	2,000	2,000	5,000
Argonne National Laboratory	—	—	2,000
Total, IGPP	11,000	12,000	15,000

Facilities Maintenance and Repair

The Department's facilities maintenance and repair activities are tied to its programmatic missions, goals, and objectives. Facilities Maintenance and Repair activities funded by the Office of Science or at SC laboratories are displayed in the following tables. SC has set maintenance targets for each of its laboratories to achieve overall facilities maintenance and repair levels consistent with the National Academy of Science recommendation of 2%–4% of replacement plant value for the SC laboratory complex.

Indirect-Funded Maintenance and Repair

Facilities maintenance and repair activities funded indirectly through overhead charges at SC laboratories are displayed below. Since this funding is allocated to all work done at each laboratory, these activities are paid for using funds from SC and other DOE organizations, as well other Federal agencies and other entities doing work at SC laboratories. Maintenance reported to SC for non-SC laboratories is also shown.

	FY 2005	FY 2006	FY 2007
	(dollars in thousands)		
Ames Laboratory	1,023	915	858
Argonne National Laboratory	26,413	26,327	28,332
Brookhaven National Laboratory	21,511	22,925	23,098
Fermi National Accelerator Laboratory	6,033	8,893	6,738
Lawrence Berkeley National Laboratory	11,175	13,000	15,440
Lawrence Livermore National Laboratory	2,735	2,767	2,822
Massachusetts Institute of Technology	569	—	—
Oak Ridge Institute for Science and Education	546	475	380
Oak Ridge National Laboratory	23,372	23,080	23,075
Oak Ridge National Laboratory facilities at Y-12	738	500	500
Pacific Northwest National Laboratory	1,868	1,895	1,476
Princeton Physics Plasma Laboratory	4,387	5,045	5,300
Sandia National Laboratory	1,905	1,960	1,999
Stanford Linear Accelerator Center	5,837	5,278	5,140
Thomas Jefferson National Accelerator Facility	2,676	3,440	2,518
Total, Indirect-Funded Maintenance and Repair	110,788	116,500	117,676

Direct-Funded Maintenance and Repair

Generally, facilities maintenance and repair expenses are funded through an indirect overhead charge. In some cases, however, a laboratory may charge maintenance directly to a specific program. An example of this might be if the maintenance were performed in a building used only by a single program. These direct-funded charges are nonetheless in the nature of indirect charges, and are not directly budgeted. The maintenance work for the Oak Ridge Office is direct funded and direct budgeted by the Science Laboratories Infrastructure program. A portion of the direct-funded maintenance and repair expenses reflects charges to non-SC programs performing work at SC laboratories.

	FY 2005	FY 2006	FY 2007
	(dollars in thousands)		
Brookhaven National Laboratory	2,290	2,974	2,974
Fermilab National Accelerator Facility	3,028	3,628	3,628
Notre Dame Radiation Laboratory	172	145	150
Oak Ridge National Laboratory	15,842	13,748	13,929
Oak Ridge National Laboratory facilities at Y-12	79	—	—
Oak Ridge Office	1,771	1,891	2,019
Stanford Linear Accelerator Center	1,079	2,520	3,480
Thomas Jefferson National Accelerator Facility	44	50	52
Total, Direct-Funded Maintenance and Repair	24,305	24,956	26,232

Deferred Maintenance Backlog Reduction

SC is planning an increased focus on reducing the backlog of deferred maintenance activities. SC will set targets for each of its laboratories for activities specifically focused on reduction of the backlog of these activities. The current deferred maintenance backlog at SC laboratories is estimated to be $660,000,000 and this amount will be our deferred maintenance baseline from which we will measure improvement. Deferred maintenance activities are primarily funded by the laboratories as overhead, charged to all uses of the laboratory facilities. The overall target for deferred maintenance at SC laboratories will be $19,800,000 in FY 2007. These deferred maintenance estimates are in addition to funding of day-to-day maintenance and repair amounts shown in the tables above. In order to assure that new maintenance requirements are not added to the backlog, SC has set targets for our laboratories that, overall, exceed 2% of the SC laboratory complex replacement plant value, commensurate with the industry standard funding level recommended by the National Academy of Sciences of 2–4% of the replacement plant value. The tables below show the targets planned for funding of deferred maintenance backlog reduction.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Argonne National Laboratory	—	—	2,574
Brookhaven National Laboratory	—	—	5,940
Fermi National Accelerator Laboratory	—	—	1,980
Lawrence Berkeley National Laboratory	—	—	2,178
Oak Ridge National Laboratory	—	—	5,544
Princeton Physics Plasma Laboratory	—	—	396
Stanford Linear Accelerator Center	—	—	792
Thomas Jefferson National Accelerator Facility	—	—	396
Total, Deferred Maintenance Backlog Reduction	—	—	19,800

Selected Administration Priorities

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Hydrogen Fuel Initiative	29,183	32,500	50,000
Climate Change Science Program	126,985	130,646	126,187
Networking and Information Technology Research and Development	246,846	255,830	344,672
National Nanotechnology Initiative	207,837	206,404	256,914
ITER (TPC)	——	19,315	60,000